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**Effect of the Removal of the Adrenal
Glands on the Copper, Zinc, and Iron
Content in the Animal Brain**

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EFFECT OF THE REMOVAL OF THE ADRENAL GLANDS ON
THE COPPER, ZINC, AND IRON CONTENT IN THE
ANIMAL BRAIN

(Vliyaniye udaleniya nadpochechnykh zhelez na sodержaniye
medi, tsinka i zheleza v golovnom mozgu zhivotnykh)

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EFFECT OF THE REMOVAL OF THE ADRENAL GLANDS ON
THE COPPER, ZINC, AND IRON CONTENT IN THE
ANIMAL BRAIN

S. P. Voroshilovskaya and V. S. Raytses*

Recent experimental and clinical data indicate that disruption of the function of the adrenal glands as well as the introduction into the organism of their hormones significantly alters the functional state of the nervous system, especially its higher sections [1 - 3].

We investigated the content of copper, zinc, and iron in the brains of animals. These substances remain constant biologically active ingredients of the brain following removal of the adrenal glands.

Total and subtotal epinephrectomy was performed on 75 male rabbits under ether anesthesia. The copper and iron content were determined by the colorimetric method and the zinc by polarography. The quantity of trace elements was calculated per 100 grams of fresh substance.

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Following complete removal of both adrenal glands from rabbits that were killed 24 hours after the operation, the concentration of zinc in the brain decreased by 46.1% on the average. The iron content rose reliably by 36%. The amount of copper did not change appreciably (Table 1).

TABLE 1. CONTENT OF TRACE ELEMENTS IN THE RABBIT BRAIN BEFORE AND AFTER TOTAL EPINEPHRECTOMY (IN mg % OF FRESH SUBSTANCE)

Element	Before operation	After total epinephrectomy		After total epinephrectomy and single determination of hormones	
		M $\pm$ m	P	M $\pm$ m	P
Copper	0.27 $\pm$ 0.12	0.23 $\pm$ 0.01	0.1	0.42 $\pm$ 0.02	<0.001
Zinc	1.03 $\pm$ 0.04	0.56 $\pm$ 0.06	<0.001	0.83 $\pm$ 0.01	<0.02
Iron	4.08 $\pm$ 0.14	5.55 $\pm$ 0.47	<0.05	11.01 $\pm$ 1.96	<0.01

In order to exclude the influence exerted upon the metabolism of microelements in the organism of animals by operational trauma and anesthesia (and to increase the survival time of the animals following complete removal of both adrenals), the rabbits were injected with cortisone (25 mg/kg) and DOKA (5 mg/kg) immediately following epinephrectomy. Following total epinephrectomy and single administration of maintenance doses of corticosteroid hormones, the concentration of copper and iron in the brain tissues of animals that died on the 5th through 20th days following the operation increased (by 55 and 170%, respectively) and the amount of zinc decreased (by 14.2%) — see Table 1.

Studies were performed under dynamic conditions from the first to the 60th days after bilateral subtotal epinephrectomy (complete removal of one adrenal and a large part of the other — Table 2.

TABLE 2. DYNAMICS OF CHANGES IN CONTENT OF COPPER, ZINC, AND IRON IN THE TISSUE OF THE RABBIT BRAIN FOLLOWING SUB-TOTAL EPINEPHRECTOMY

Element	Statistical index	Before operation	Day after operation					
			1 st	10 th	20 th	30 th	40 th	60 th
Copper	M	0.27	0.33	0.25	0.32	0.32	0.13	0.14
	$\pm m$	0.12	0.02	0.02	0.04	0.04	0.001	0.005
	P		<0.05	>0.5	>0.5	>0.5	<0.001	<0.001
Zinc	M	1.03	0.98	0.92	0.82	0.85	0.82	0.77
	$\pm m$	0.04	0.15	0.07	0.07	0.04	0.02	0.04
	P		0.5	0.2	<0.05	<0.05	<0.01	<0.01
Iron	M	4.08	6.7	6.2	4.2	4.3	8.1	5.5
	$\pm m$	0.14	0.6	0.5	0.4	0.3	0.4	0.6
	P		<0.01	<0.01	0.5	0.5	<0.001	<0.1

The copper content in the brain varied within normal limits in the course of the first month following the operation; later, however, it decreased sharply so that by the 60th day it was an average of 68% of the initial value. The amount of zinc gradually decreases beginning with the 20th day after the operation, and is about 75% of normal by the end of the period covered by the study. The concentration of iron in the brain tissue increases by 64% beginning on the first day of the experiment, remaining high until the 10th day. Between the 20th and 30th days, the amount of iron drops and returns almost to its initial level, then rises again sharply by the 40th day (by 98%). Toward the end of the experiments (60th day), the iron content in the brain remains constant.

Hence, both complete and partial removal of the adrenal glands in the rabbit leads to development of a deficit of zinc in the brain tissue and an increase in the iron content. We know that copper and iron, as metallic components, go into the makeup of a number of oxidative enzymes and play an important role in the processes of tissue respiration, [6].

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cont. from 3
It may be assumed that the above-mentioned changes in the quantitative content of copper, zinc, and iron in the animal brain following epinephrectomy are of definite significance in the pathogenesis of morpho-functional disturbances of the brain, especially its higher sections, which are observed in the case of insufficient function of the adrenal glands. [3 - 5].

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